IA-09

Processing of $BiFeO_3$ thin films to control their dielectric response

S.P. Reis[1,2], E.B. Araujo[1]

[1]*Department of Physics and Chemistry, São Paulo State University, 15385-000 Ilha Solteira, Brazil*
eudes.borges@unesp.br

[2]*Federal Institute of Education, Science and Technology of São Paulo, 15503-110 Votuporanga, Brazil*

Leakage current in the $BiFeO_3$ thin films is a problem that still limits their practical applications, despite the announced potential of this multiferroic for the next generation of microelectronic devices. The mechanisms behind the large leakage current observed in $BiFeO_3$ are often associated to the valence fluctuation of the Fe ions, formation of oxygen vacancies and inhomogeneities associated to the Bi volatilization during synthesis. The search for alternatives to control the leakage current in this system has stimulated the recent research in this field. In the present work, the impact of defects on the electrical properties of $BiFeO_3$ thin films is reported for a set of samples with different defects introduced during the synthesis. Secondary phases and oxygen vacancies were the most apparent defects during film synthesis compared to single-phase films. The electrical properties of the films were studied in terms of impedance and electric modulus spectroscopies, and electrical conductivity as a function of frequency (10^2-10^6 Hz), temperature (300-480 K) and *dc* bias field (0-60 $kV.cm^{-1}$). From thermally activated process, the activation energies of dielectric relaxation and conduction were very similar for films with secondary phases. The activation energies of conduction, 0.42 eV (grain) and 0.43 eV (grain boundary), were attributed to the first ionization level of oxygen vacancies in these films. On the other hand, the activation energy of conduction increases to 0.68 eV for single-phase film post annealed in oxygen, an indicative of effective reduction of defects in this film and that second ionization oxygen vacancies are responsible for conduction in this sample. DC bias influence on dielectric properties reveal an electrically excited relaxation process similar to the thermally activated. The Cole-Cole curves of complex impedance were greatly depressed by increasing dc bias, whereas the Cole-Cole curves of electric modulus were almost independent of bias. These results are discussed in terms of interfacial polarization in the low frequency range. The different scenarios demonstrated the importance of the synthesis to control the electrical conductivity and other related parameters of $BiFeO_3$ thin films.